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IGNITION SYSTEM

Two types of ignition systems are being considered at this time. One type involves the use of a standard magneto for spark while the other is a departure from any standard system. This second system proposes the use of a standard breaker-point arrangement, but uses 400 cycles AC power instead of DC as is used in conventional systems. The analysis of this system follows:

Output frequency = 400 cps.
Generator Poles = 8
Engine-Generator Speed = 6000 RPM

$$\frac{6000}{60} = 100 \text{ R.P.S.}$$

Cycles for one shaft revolution:

$$\frac{400}{100} = 4 \text{ cycles/ revolution}$$

Since the engine is of the two cycle type, it is necessary to provide one spark impulse per revolution. Also, the peak of any one 400 cycle wave must be adjusted initially to coincide with spark supplied to the engine. This will be shown below.

To operate coil, breaker points must close on zero voltage point of any one cycle of the 400 cycle output. Points must open approximately 1/4 cycle later at the crest of the 400 cycle output to generate and utilize maximum flux in the ignition coil.

$$\text{One revolution} = 4 \text{ cycles} = 360^\circ$$

$$\text{One cycle} = \frac{360}{4} = 90^\circ$$

$$1/4 \text{ cycle} = \frac{90}{4} = 22.5^\circ$$

From this we determine that the breaker point actuating cam must close for 22.5° and remain open for 337.5° of each revolution.

Studying the problem further, we become aware of two limiting factors to proper operation. First is the possibility of reduction in spark due to the points not being closed long enough to allow the coil primary current to reach a steady state value before point opening. This current can be expressed as follows:

$i =$ current at any time "t" $= \frac{E}{R}(1 - \epsilon^{-\frac{t}{T}})$

$E =$ peak value of 400 cycle voltage.

$R =$ ignition coil primary resistance.

$\epsilon = 2.718$ $t =$ time in seconds $T = \frac{L}{R}$

$L =$ ignition coil primary inductance.

The time required for the current to reach 63% of steady state is:

$$T = \frac{L}{R}$$

To reach 87%, twice as much time is required.

We have procured a coil which seems applicable to the job. It has the following characteristics:

Primary inductance = 11 Millihenry.

Primary Resistance = 2.57 ohms.

Secondary Resistance = 9000 ohms.

From these values:

$$T = \frac{L}{R} = \frac{11 \times 10^{-3}}{2.57} = 4.28 \text{ Milliseconds}$$

Time lapse for 22.5 degrees:

$$\frac{22.5}{360} = .0625 \text{ revolutions}$$

Time required for 1 revolution at 100 RPS:

$$\frac{1}{100} \text{ seconds} = 10 \text{ MS.}$$

Time lapse for 22.5 degrees:

$$10 \times .0625 = .625 \text{ Milliseconds}$$

Since the speed of revolution allows only .625 milliseconds for charging and it is necessary to have 4.28 milliseconds to reach 63% of the steady state current value, it appears that under these conditions little energy would be stored resulting in very unsatisfactory spark. Since the charging time in inversely proportional to the circuit or charging resistance, the time could be

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reduced by the addition of resistance in the circuit, increasing the voltage correspondingly to maintain the steady state value the same. This should be carried to a point where the time constant is somewhat less than .625 milliseconds since all of the above calculations are based on square wave input conditions and this system will be essentially sine wave driven. This will have the effect of increasing the time constant.

The second problem as mentioned above relates to the time required for the discharge into the spark plug. Since the source of voltage for the ignition system is in series with the spark discharge circuit at all times it follows that the primary energy could be reduced by the 400 cycle sine wave voltage returning to zero during the discharge time of the coil-condenser circuit. (See Fig. 1). This will not occur if the damped wave train discharge is mostly dissipated in approximately .3 milliseconds. If the damped wave train frequency equals 6000 cycles per second, .3 milliseconds would correspond to two cycles which seems low. However, most of these conditions can best be observed by an actual operating circuit.

Since the engine breaker-point system is not yet available, an electronic circuit has been devised to attempt to simulate the operating conditions. It is shown schematically in Fig. 2. Basically, it consists of a 100 cycle multivibrator whose output is differentiated and used to control a slave flip-flop circuit which in turn operates the relay to simulate the breaker points. The slave flip-flop circuit has control of the "on" time of the relay which simulates the dwell time of the breaker points. The 100 cycle multivibrator has synchronizing input terminals with phase shifting network which will be connected to the 400 cycle power source. With this it will be possible to adjust the relay contact closing with reference to the 400 cycle source. In this way we can close the relay contacts at most any point on the 400 cycle voltage curve.

A motor-driven magneto test setup is being assembled for magneto and noise tests. If the points used on this magneto can be set to a suitable dwell time, it will be possible to make additional study of the coil ignition system by using these points for the coil breaker-points.

IGNITION SYSTEM - INTERFERENCE STUDY

The magneto test setup mentioned above incorporates the magneto and dummy spark plug in a shielded case. The magneto will be driven through a suitable pulley-belt arrangement from a 115 volt 60 cycle motor. The pulley ratios have been selected to operate the magneto at 6000 RPM, in order to simulate actual operating

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conditions. Using this setup we hope to make a complete noise problem analysis of the ignition system, in order to simplify the problem as much as possible in the final unit. This unit should be completed within one week, ready for measurements.

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GENERATOR DESIGN

The problem of generator size has been mutually agreed to by [redacted] and 25X1
[redacted]. Detailed design and drafting is 25X1
in process at [redacted] at the present time. They 25X1
are to supply [redacted] with all necessary drawings of the 25X1
design such that tooling may be released as soon as the drawings are received.

[redacted] will supply the tooling and fabricate sufficient 25X1
stator rings and pole tips for two generators. These parts
along with shafts supplied by [redacted] will 25X1
be sent to [redacted] for winding, final assembly and 25X1
test.

[redacted] 25X1

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